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(54) **Device and method for protecting electronic units in a satellite from electrical disturbance**

Vorrichtung und Verfahren zum Schutz von elektronischen Einheiten in einem Satelliten gegen elektrische Störungen

Procédé et dispositif pour la protection d'unités électroniques dans un satellite contre les perturbations électriques

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Description

[0001] The present invention relates to a method for electrically isolating electronic components within a platform module of a satellite from electrical disturbance, and to a corresponding satellite platform module.

[0002] A satellite is a type of spacecraft that orbits either the earth or another body of the solar system. There are two main classes of satellites: information satellites and communications satellites. Information satellites transmit signals related to atmospheric and meteorological data, infrared, ultraviolet, gamma and X-ray studies of celestial objects, and surveys of the earth's shape, surface, and resources. Communications satellites receive radio frequency signals from earth by means of highly directional aeri-als and return them to another earth location for purposes such as long-distance telephony and TV broadcasting.

[0003] A satellite typically includes a payload module and a platform module. For a communications satellite, the payload is the communications equipment necessary to perform the mission. The platform typically includes the following subsystems: (1) power; (2) attitude and control; (3) propulsion; (4) on-board telemetry tracking and command (TTC); (5) thermal control; and (6) structure. These subsystems play a vital role throughout the satellite's operational life.

[0004] The structure of the satellite platform module includes a configuration of rigid panels capable of withstanding intense mechanical stresses imposed during various phases of the mission. The panels are typically manufactured from strong lightweight materials such as aluminum honeycomb combined with aluminum or carbon fiber face sheets. Panel weight is further minimized by providing holes through the solid material.

[0005] An electrical shield called a faraday cage is commonly used to protect the platform electronic units (e.g. power distribution unit and power controller unit) from unwanted electrical disturbances such as electrostatic discharge. Previous satellites have been built with the electronic units and propulsion components (e.g. propulsion tanks and thrusters) dispersed throughout the platform. In order to protect the electronic units, the faraday cage must surround the entire platform. One method of accomplishing this is to wrap the platform in thermal blankets containing layers of metallized material. The blankets are then connected together by blanket ground wires to form a faraday cage around the platform. An alternative approach is to incorporate within the platform panels a material such that, when the panels are connected, a faraday cage is created.

[0006] The previous methods suffer from drawbacks. In the first method, numerous wires are required to completely connect the blankets together. The wire connections, which are often missed, cause penetrations in the faraday cage. In the second method, the solid panels add weight and increase satellite cost. In both methods, multiple penetrations of the faraday cage are required

in order to make the necessary connections from propulsion components located outside the platform to propulsion components located inside the platform.

[0007] Accordingly, there exists a need for a device that provides adequate shielding for the electronic components of a satellite while minimizing satellite weight.

[0008] US 4,599,680 discloses a packaging arrangement for a spacecraft computer. The packaging comprises a base plate which is fixed to an adapter bracket and, further, via a metal gasket to a cover. The cover and the base plate are made of electrical and heat conductive material, such as aluminum. The packaging is therefore resistant to electromagnetically noisy environments. The power for running the power supply is received through a power connector and is immediately filtered through a filter element to prevent unwanted spikes or electromagnetic interference. The filter element prevents any external interference from coming into the computer over the power lines.

[0009] EP 0 484 853 A1 discloses a method and a device for protecting electronic components against radiation. In order to reduce the weight of the shielding measurements, this reference suggests to place the shielding material in dependence of the angle of incidence of the radiation.

[0010] From the article "Subtleties of signal line filters" published in NEW ELECTRONICS, volume 27, No. 4, April 1994, it is known to use small ferrite inductors and diode protection in filters. Furthermore, US 5,287,074 discloses the application of ferrite shields for protection against electromagnetic noise. According to this reference, two ferrite elements are arranged in series surrounding a signal line.

[0011] It is an object of the present invention to provide an improved method for electrically isolating electronic components within a platform module of a satellite while minimizing satellite weight. It is a further object to provide a corresponding satellite platform module.

[0012] The object is achieved by a method comprising the steps of :

forming a structure that creates a faraday cage, housing said electronic components within said structure, and

locating the propulsion components of the satellite outside the structure whereby the electronic units and the propulsion components are separated.

[0013] This object is further achieved by a platform module of a satellite including propulsion components and electronic components, with said electronic components being platform electronic units of the satellite, and further including a device for electrically isolating said electronic components from electrical disturbance, said device comprising a structure forming a faraday cage, wherein said electronic components are contained within said structure, and wherein the propulsion components are located outside the structure, whereby the

electronic units and the propulsion components are separated.

[0014] The present invention provides a device and method which can be implemented in the structure subsystem of a satellite. Specifically, the device and method of the present invention are capable of protecting a satellite from unwanted electrical disturbance without increasing the satellite's weight.

[0015] According to a preferred embodiment of the present, the electronic units and propulsion components are separated. Further, the electronic units are grouped closely together to minimize the size of the structure needed to house them. Preferably, there are two sets of electronics units located on the satellite. The structure that houses the electronic units is preferably made from solid panels containing a sufficient amount of aluminum to create a faraday cage around the units. The faraday cage protects the units from electrical disturbances such as the electrostatic discharge formed on the satellite during its mission.

[0016] The device and method of the present invention provides several advantages to the structural design of a satellite. The modular placement of electronic units and propulsion components separates critical electronics from propulsion components, thereby allowing a structure with solid panels to house the electronic components without significantly increasing the satellite's weight. The modular placement also allows the faraday cage to be broken into discrete structures connected via a cluster of wires called a harness. Because the propulsion components are located outside the faraday cage, and the electronic units are centrally located, the number of wire connections that penetrate the cage are minimized. Thus a faraday cage constructed according to the present invention is penetrated only where the harness penetrates the two structures. In a first preferred embodiment, the harness is covered by a braided metal in the form of a tubular mesh that wraps 360 degrees around the harness and connects to the two structures via connectors. In a second preferred embodiment, two harnesses are used and are covered by a shielded cable tray made from an aluminum material to provide additional protection from unwanted electrical disturbances.

[0017] In another aspect of the invention, modular placement of electronic units allows a novel method of shielding the wires that connect the electronics units to components located outside the faraday cage. In the presently preferred embodiment, wires from the electronics units are connected to a first side of a filter assembly which is located on a panel of the electronic unit housing. Wires connected to the second side of the filter assembly are routed to the components located outside the faraday cage. The filter assembly electronically filters undesired signals originating from components outside the faraday cage before routing the desired signals to electronics components inside the faraday cage. The new technique alleviates the problems caused by pre-

vious methods of individually wrapping and grounding each wire connecting the electronics units to components outside the faraday cage.

[0018] The invention itself, together with further objects and attendant advantages, will be understood by reference to the following detailed description, taken in conjunction with the accompanying drawings.

Figure 1 is a diagram of a satellite capable of utilizing the present invention.

Figure 2a illustrates a first preferred embodiment for providing faraday cage protection to the electronics units of the satellite of Figure 1.

Figure 2b illustrates a second preferred embodiment for providing faraday cage protection to the electronics units of the satellite of Figure 1.

Figure 3 illustrates several views of a filter assembly that can be used in the faraday cage protection scheme of Figure 2.

[0019] A spacecraft or satellite 10 capable of utilizing the present invention is shown in Figure 1. The satellite 10 has a spacecraft body 12 which includes a lower bus module or platform 14 and an upper payload module 16. Attached to the aft end of the lower bus module 14 are a plurality of engines. These engines include a centrally positioned liquid orbital thruster (not shown), four chemical propulsion engines 24 located at the corners of the bus module 14 and two pairs of xenon ion propulsion engines 26 (one pair shown). Lower bus module 14 contains fuel tanks (not shown) and various power and control modules that operate the engines and power the payload module 16. Bus module 14 further includes a pair of solar panels 18 that convert sunlight into electricity. The electricity is sent to batteries (not shown) located on the bus module 14. Bus module 14 also has a pair of antennae 20, which receive signals from an earth ground station. The antennae 20 reflect the received signals into reflectors 22, which in turn, reflect the signals into receivers (not shown). The antennae 20 are used to control the satellite 10 and to send signals to the ground station.

[0020] Payload module 16 is attached to the bus module 14 and contains a variety of electronic equipment which may contain a number of sensors (not shown). The electronic equipment processes information gathered by the sensors and sends the processed information back to the ground station via antennae 20. The gathered information may concern for example, communications, weather observation, and navigational information.

[0021] Figure 2a illustrates a first preferred embodiment of the Faraday cage configuration 30 of the present invention. The configuration 30 preferably includes two shielded faraday structures 32, 34 which are located on the north panel 28 and south panel (not shown) of the bus module 14 of Figure 1. The shielded faraday structures 32, 34 house the electronic units on

board the satellite.

[0022] The panels of the structures 32, 34 are constructed of a honeycomb core adhesively affixed between two solid aluminum face sheets. In the presently preferred embodiment, the cell size of the core is 0,476 cm = 3/16 of an inch, the thickness of the core is 1,9 to 2,54 cm = 3/4 to 1 inch, and the thickness of the aluminum face sheets is 0,254 mm to 0,5 mm = 10 to 20 mils. The panels are connected to form a faraday cage around the electronic units using known RF sealing materials. The exact dimensions of the structures 32, 34 should be chosen according to the particular application.

[0023] In the present example, the structures 32, 34 are rectangular boxes. The faraday cages of the boxes 32, 34 are electrically connected via a bundle of wires or a harness (not shown) surrounded by a braided metal mesh 64. The braided metal mesh 64 is connected to the boxes 32, 34 via connectors 66 (only one shown) commonly known in the art. A suitable metal mesh 64 is mil-std space qualified commonly known in the art.

[0024] In a second preferred embodiment, the faraday cages of the boxes 32, 34 are electrically connected via two bundles of wires or harnesses (not shown) surrounded by shielded cable trays 36, 38. The bundles of wires are preferably 2,54 cm = 1 inch thick. Suitable wires are mil-std space hardware wires commonly known in the art. The shielded cable trays 36, 38 preferably comprise two rectangular sheets of aluminum 0,38 to 0,5 mm = 15 to 20 mils thick. The two rectangular sheets surround the harness and are held together by screws (not shown). The shielded cable trays 36, 38 provide continuity of the faraday cage of structures 32, 34.

[0025] Connections between electronics units and units located outside the faraday cage are made through filter assemblies 40. Figure 3a illustrates a perspective view of a filter assembly 40 which includes a box structure 46, an aluminum lid 42, and an RF gasket 44 commonly used in the art to ensure electrical conductivity. The box structure 46 includes two flanges 48 for mounting the assembly 40 to a panel of the faraday cage structure 32, 34. The panels of the box structure 46 are preferably made from aluminum. One panel 50 of the assembly 40 is configured to accept 66 pin circular input connectors 52 (Figure 3b). Another panel (not shown) of the assembly 40 is configured to accept 66 pin circular output connectors 54 (Figure 3b). The connectors 52, 54 are off-the-shelf devices commonly known in the art.

[0026] Figures 3b and 3c illustrate further details of the filter assembly 40. Inside the filter assembly box structure 46, the wire end of the input connector 52, which is represented by filter pin 52a, is coupled to a first end of a ferrite 56. The other end of the ferrite 56 is connected to the first end of a ferrite 58. The second end of the ferrite 58 is coupled to the first end of a ferrite 60. The second end of the ferrite 60 is coupled to the first end of a diode 62. The second end of the diode 62 is coupled to the wire end 54a of the output connector

54. The ferrites 56, 58, 60 and diode 62 are chosen according to mil-std specifications and should be approved for space applications. The particular size of ferrites and diode should be chosen according to the type and size of signals that are to be filtered.

[0027] The components located outside the faraday cage structures 32, 34 are coupled to the pin ends of the 66 pin circular input connectors 52. The electronic units located inside the faraday cage structures 32, 34 are coupled to the pin ends of the 66 pin circular output connectors 54. Signals originating from components outside the faraday cage are electronically filtered through the ferrites 56, 58, 60 and diode 62 before reaching the electronic units inside the faraday cage structures 32, 34.

[0028] The device and method of the present invention provide several advantages to the structural design of a satellite. Modular placement of units and propulsion components allows a structure with solid panels to be used to house the electronic units without significantly increasing the satellite's weight. Modular placement minimizes penetrations of the faraday cage, thereby eliminating damage to the electronic units. Modular placement also significantly decreases the probability of digital electronics equipment randomly changing states due to electrical disturbances. Connections between electronic units and components outside the faraday cage through filter assemblies eliminate the problems associated with individual connections such as bad wraps, bad grounds and forgotten grounds.

[0029] It should be understood that a wide range of changes and modifications can be made to the preferred embodiment described above. For example, although rectangular faraday boxes are illustrated, the invention can be implemented using various configurations. It is therefore intended that the foregoing detailed description be regarded as illustrative rather than limiting and that it be understood that it is the following claims, including all equivalents, which are intended to define the scope of this invention.

Claims

1. A platform module of a satellite (10) including propulsion components and electronic components, with said electronic components being platform electronic units of the satellite, and further including a device for electrically isolating said electronic components from electrical disturbance, said device comprising a structure (32, 34) forming a faraday cage, wherein said electronic components are contained within said structure (32, 34), and wherein the propulsion components are located outside the structure (32, 34), whereby the electronic units and the propulsion components are separated.
2. The platform module of claim 1, characterized by

said device comprising:

a first structure (32) forming a first faraday cage,
 a first plurality of said electronic components contained within said first structure (32),
 a second structure (34) forming a second faraday cage,
 a second plurality of said electronic components contained within said second structure (34), and
 a plurality of wires (36, 38, 64) connecting a predetermined number of said first electronic components to a predetermined number of said second electronic components.

3. The platform module of claim 2, **characterized in that** said first structure (32) and second structure (34) comprise panels (50) that incorporate an electrical conductor.

4. The platform module of claim 2 or 3, **characterized in that** said plurality of wires (36, 38, 64) are covered by a braided metal mesh (64).

5. The platform module of any of claims 1 - 4, **characterized in that** said device further comprises a filter assembly (40).

6. The platform module of claim 5, **characterized in that** said filter assembly (40) comprises:

a plurality of ferrites (56, 58, 60) connected in a serial manner; and
 a diode (62) serially connected to said plurality of ferrites (56, 58, 60).

7. The platform module of claim 5 or 6, **characterized in that** said filter assembly (40) further comprises:

an aluminum box structure (46) comprising a plurality of panels (50); and
 connectors (52, 54) mounted on panels (50) of said structure (46) whereby said ferrites (56, 58, 60) and said diode (62) are connected between said connectors (52, 54).

8. A method of electrically isolating electronic components within a platform module of a satellite (10) from electrical disturbance, wherein said platform module includes propulsion components and said electronic components, and wherein said electronic components are platform electronic units of the satellite, said method comprising the steps of:

forming a structure (32, 34) that creates a faraday cage,
 housing said electronic components within said

structure (32, 34), and

locating the propulsion components outside the structure (32, 34) whereby the electronic units and the propulsion components are separated.

9. The method of claim 8, **characterized by** the steps of:

forming a first structure (32) that creates a first faraday cage,
 housing a first plurality of said electronic components within said first structure (32),
 forming a second structure (34) that creates a second faraday cage,
 housing a second plurality of electronic components within said second structure (34), and
 connecting a predetermined number of said first electronic components to a predetermined number of said second electronic components.

10. The method of claim 9, **characterized in that** the step of connecting is performed by a plurality of shielded wires (36, 38, 64).

11. The method of claim 9 or 10, **characterized in that** it further comprises connecting a predetermined number of said plurality of electronic components to a predetermined number of components located outside said structures (32, 34).

12. The method of claim 11, **characterized in that** the step of connecting comprises:

connecting a plurality of ferrites (56, 58, 60) in a serial manner wherein said plurality has a first end and a second end, the first end of said plurality connected to a wire side (52a) of an input connector (52),
 connecting a diode (62) between said second end of said plurality of ferrites and a wire side (54a) of an output connector (54),
 connecting said predetermined number of components located outside said structures (32, 34) to a pin side of said input connector (52), and
 connecting said predetermined number of said plurality of electronic components to a pin side of said output connector (54).

Patentansprüche

1. Plattformmodul eines Satelliten (10) mit Antriebskomponenten und elektronischen Komponenten, wobei die elektronischen Komponenten elektronische Einheiten der Plattform des Satelliten sind, und ferner mit einer Vorrichtung zur elektrischen Isolation der elektronischen Komponenten von elektrischen Störungen, wobei die Vorrichtung eine

Struktur (32, 34) aufweist, die einen Faraday'schen Käfig ausbildet, wobei die elektronischen Komponenten innerhalb der Struktur (32, 34) enthalten sind, und wobei die Antriebskomponenten außerhalb der Struktur (32, 34) angeordnet sind, wodurch die elektronischen Einheiten und die Antriebskomponenten voneinander getrennt sind.

2. Plattformmodul nach Anspruch 1, **dadurch gekennzeichnet, dass** die Vorrichtung aufweist:

eine erste Struktur (32), die einen ersten Faraday'schen Käfig ausbildet,
eine erste Vielzahl von elektronischen Komponenten, die innerhalb der ersten Struktur (32) angeordnet sind,
eine zweite Struktur (34), die einen zweiten Faraday'schen Käfig ausbildet,
eine zweite Vielzahl von elektronischen Komponenten, die innerhalb der zweiten Struktur (34) angeordnet sind, und
eine Vielzahl von Leitungen (36, 38, 64), die eine bestimmte Anzahl der ersten elektronischen Komponenten mit einer bestimmten Anzahl der zweiten elektronischen Komponenten verbinden.

3. Plattformmodul nach Anspruch 2, **dadurch gekennzeichnet, dass** die erste Struktur (32) und die zweite Struktur (34) Platten (50) aufweisen, die einen elektrischen Leiter beinhalten.

4. Plattformmodul nach Anspruch 2 oder 3, **dadurch gekennzeichnet, dass** die Vielzahl von Leitungen (36, 38, 64) von einem geflochtenen Metallgitter (64) bedeckt sind.

5. Plattformmodul nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** die Vorrichtung ferner eine Filteranordnung (40) aufweist.

6. Plattformmodul nach Anspruch 5, **dadurch gekennzeichnet, dass** die Filteranordnung (40) aufweist:

eine Vielzahl von Ferriten (56, 58, 60), die in einer seriellen Art und Weise verbunden sind; und
eine Diode (62), die seriell mit der Vielzahl von Ferriten (56, 58, 60) verbunden ist.

7. Plattformmodul nach Anspruch 5 oder 6, **dadurch gekennzeichnet, dass** die Filteranordnung (40) ferner aufweist:

eine Kastenstruktur (46) aus Aluminium, die eine Vielzahl von Platten (50) aufweist; und
Konnektoren (52, 54), die auf den Platten (50)

der Struktur (46) angeordnet sind, wobei die Ferrite (56, 58, 60) und die Diode (62) zwischen den Konnektoren (52, 54) angeordnet sind.

8. Verfahren zum elektrischen Isolieren von elektronischen Komponenten innerhalb eines Plattformmoduls eines Satelliten (10) gegenüber elektrischen Störungen, wobei das Plattformmodul Antriebskomponenten und die elektronischen Komponenten beinhaltet, und wobei die elektronischen Komponenten elektronische Einheiten der Plattform des Satelliten sind, wobei das Verfahren die folgenden Schritte aufweist:

Ausbilden einer Struktur (32, 34), die einen Faraday'schen Käfig erzeugt,
Umhüllen der elektronischen Komponenten in der Struktur (32, 34), und
Anordnen der Antriebskomponenten außerhalb der Struktur (32, 34), wodurch die elektronischen Einheiten und die Antriebskomponenten getrennt werden.

9. Verfahren nach Anspruch 8, **gekennzeichnet durch** die Schritte:

Ausbilden einer ersten Struktur (32), die einen ersten Faraday'schen Käfig erzeugt,
Umhüllen einer ersten Vielzahl der elektronischen Komponenten in der ersten Struktur (32),
Ausbilden einer zweiten Struktur (34), die einen zweiten Faraday'schen Käfig erzeugt,
Umhüllen einer zweiten Vielzahl der elektronischen Komponenten in der zweiten Struktur (34), und
Verbinden einer bestimmten Anzahl der ersten elektronischen Komponenten mit einer bestimmten Anzahl der zweiten elektronischen Komponenten.

10. Verfahren nach Anspruch 9, **dadurch gekennzeichnet, dass** der Schritt des Verbindens mit einer Vielzahl von abgeschirmten Leitungen (36, 38, 64) ausgeführt wird.

11. Verfahren nach Anspruch 9 oder 10, **dadurch gekennzeichnet, dass** es ferner ein Verbinden einer bestimmten Anzahl der Vielzahl von elektronischen Komponenten mit einer bestimmten Anzahl an Komponenten, die außerhalb der Strukturen (32, 34) angeordnet sind, beinhaltet.

12. Verfahren nach Anspruch 11, **dadurch gekennzeichnet, dass** der Schritt des Verbindens aufweist:

Verbinden einer Vielzahl von Ferriten (56, 58,

60) in einer seriellen Art und Weise, wobei die Vielzahl ein erstes Ende und ein zweites Ende besitzt, wobei das erste Ende der Vielzahl mit einer Leitungsseite (52a) eines eingangsseitigen Konnektors (52) verbunden wird, Verbinden einer Diode (62) zwischen dem zweiten Ende der Vielzahl von Ferriten und einer Leitungsseite (54a) eines ausgangsseitigen Konnektors (54), Verbinden der bestimmten Anzahl an außerhalb der Strukturen (32, 34) angeordneten Komponenten mit einer Stiftseite des eingangsseitigen Konnektors (52), und Verbinden der bestimmten Anzahl der Vielzahl von elektronischen Komponenten mit einer Stiftseite des ausgangsseitigen Konnektors (54).

Revendications

1. Module de plate-forme pour un satellite (10) incluant des composants de propulsion et des composants électroniques, lesdits composants électroniques étant des unités électroniques de plate-forme du satellite, et incluant en outre un dispositif pour isoler électriquement lesdits composants électroniques des perturbations électriques, ledit dispositif comprenant une structure (32, 34) formant une cage de Faraday, dans lequel lesdits composants électroniques sont enfermés au sein de ladite structure (32, 34), et dans lequel les composants de propulsion sont disposés à l'extérieur de la structure (32, 34), ce par quoi les unités électroniques et les composants de propulsion sont séparés.

2. Module de plate-forme selon la revendication 1, **caractérisé en ce que** ledit dispositif comprend :

une première structure (32) formant une première cage de Faraday,
une première pluralité desdits composants électroniques enfermés dans ladite première structure (32),
une deuxième structure (34) formant une deuxième cage de Faraday,
une deuxième pluralité desdits composants électroniques enfermés dans ladite deuxième structure (34), et
une pluralité de fils (36, 38, 64) connectant un nombre prédéterminé desdits premiers composants électroniques à un nombre prédéterminé desdits deuxièmes composants électroniques.

3. Module de plate-forme selon la revendication 2, **caractérisé en ce que** lesdites première structure (32) et deuxième structure (34) comprennent des panneaux (50) qui intègrent un conducteur électri-

que.

4. Module de plate-forme selon la revendication 2 ou 3, **caractérisé en ce que** ladite pluralité de fils (36, 38, 64) sont couverts par un treillis métallique tressé (64).

5. Module de plate-forme selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** ledit dispositif comprend en outre un ensemble de filtrage (40).

6. Module de plate-forme selon la revendication 5, **caractérisé en ce que** ledit ensemble de filtrage (40) comprend :

une pluralité de ferrites (56, 58, 60) connectées en série ; et
une diode (62) connectée en série à ladite pluralité de ferrites (56, 58, 60).

7. Module de plate-forme selon la revendication 5 ou 6, **caractérisé en ce que** ledit ensemble de filtrage (40) comprend en outre :

une structure de boîte en aluminium comprenant une pluralité de panneaux (50) ; et
des connecteurs (52, 54) montés sur des panneaux (50) de ladite structure (46) au moyen desquels lesdites ferrites (56, 58, 60) et ladite diode (62) sont connectées entre lesdits connecteurs (52, 54).

8. Procédé pour isoler électriquement des composants électroniques à l'intérieur d'un module de plate-forme d'un satellite (10) des perturbations électriques, dans lequel ledit module de plate-forme inclut des composants de propulsion et lesdits composants électroniques, et dans lequel lesdits composants électroniques sont des unités électroniques de plate-forme du satellite, ledit procédé comprenant les étapes qui consistent à :

former une structure (32, 34) qui crée une cage de Faraday,
loger lesdits composants électroniques dans ladite structure (32, 34), et
disposer les composants de propulsion à l'extérieur de la structure (32, 34), ce par quoi les unités électroniques et les composants de propulsion sont séparés.

9. Procédé selon la revendication 8, **caractérisé par** les étapes consistant à :

former une première structure (32) qui crée une première cage de Faraday,
loger une première pluralité desdits compo-

sants électroniques dans ladite première structure (32),
 former une deuxième structure (34) qui crée une deuxième cage de Faraday,
 loger une deuxième pluralité de composants électroniques dans ladite deuxième structure (34), et
 connecter un nombre prédéterminé desdits premiers composants électroniques à un nombre prédéterminé desdits deuxièmes composants électroniques.

10. Procédé selon la revendication 9, **caractérisé en ce que** l'étape de connexion est réalisée par une pluralité de fils blindés (36, 38, 64).

11. Procédé selon la revendication 9 ou 10, **caractérisé en ce qu'il** comprend en outre la connexion d'un nombre prédéterminé de ladite pluralité de composants électroniques à un nombre prédéterminé de composants électroniques disposés en dehors desdites structures (32, 34).

12. Procédé selon la revendication 11, **caractérisé en ce que** l'étape de connexion comprend :

la connexion d'une pluralité de ferrites (56, 58, 60) en série, dans laquelle ladite pluralité a une première extrémité et une deuxième extrémité, la première extrémité de ladite pluralité étant connectée à un côté de fil (52a) d'un connecteur d'entrée (52),
 la connexion d'une diode (62) entre ladite deuxième extrémité de ladite pluralité de ferrites et un côté de fil (54a) d'un connecteur de sortie (54),
 la connexion dudit nombre prédéterminé de composants disposés en dehors desdites structures (32, 34) à un côté de broche dudit connecteur d'entrée (52), et
 la connexion dudit nombre prédéterminé de ladite pluralité de composants électroniques à un côté de broche dudit connecteur de sortie (54).

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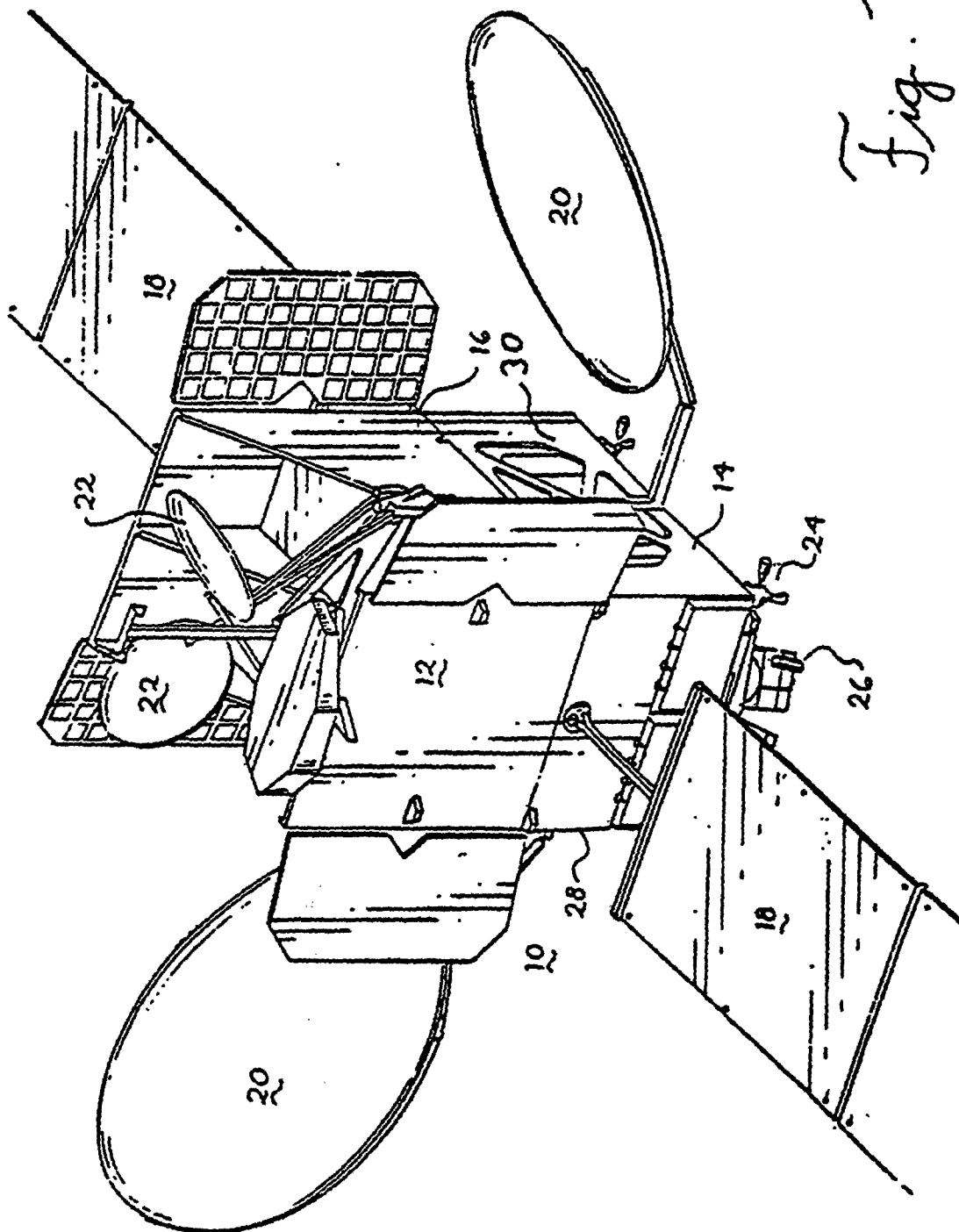


Fig. 1

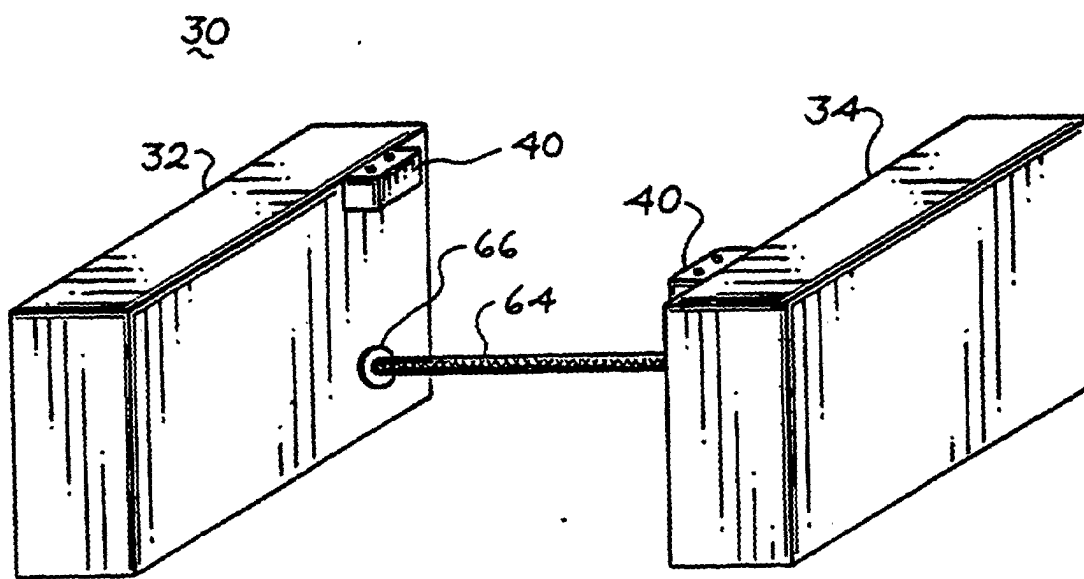


Fig. 2A

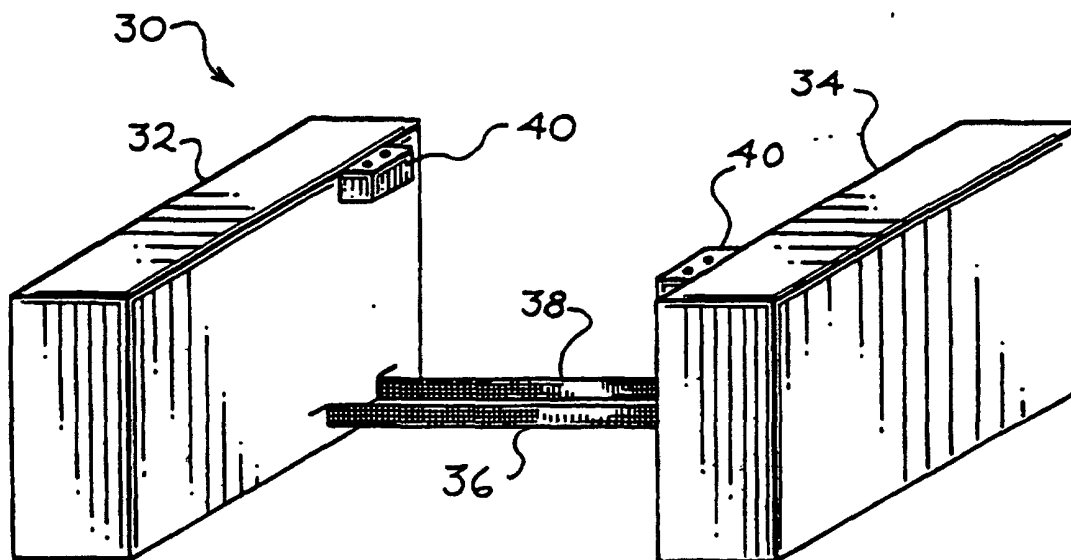


Fig. 2B

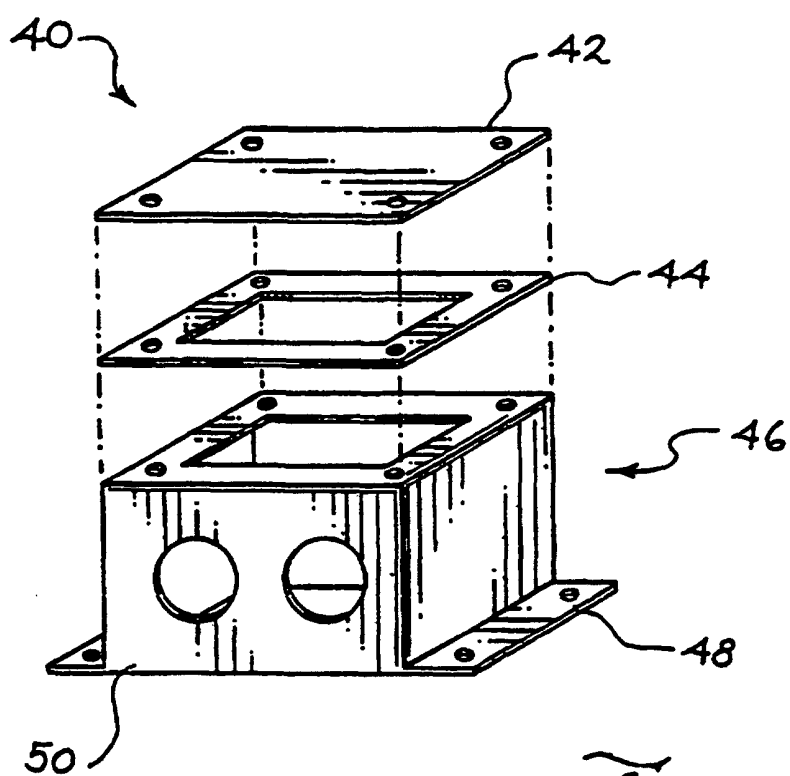


Fig. 3A

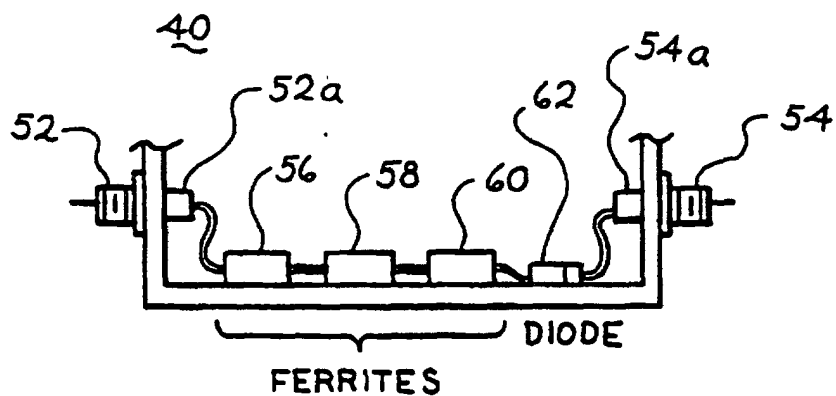


Fig. 3B

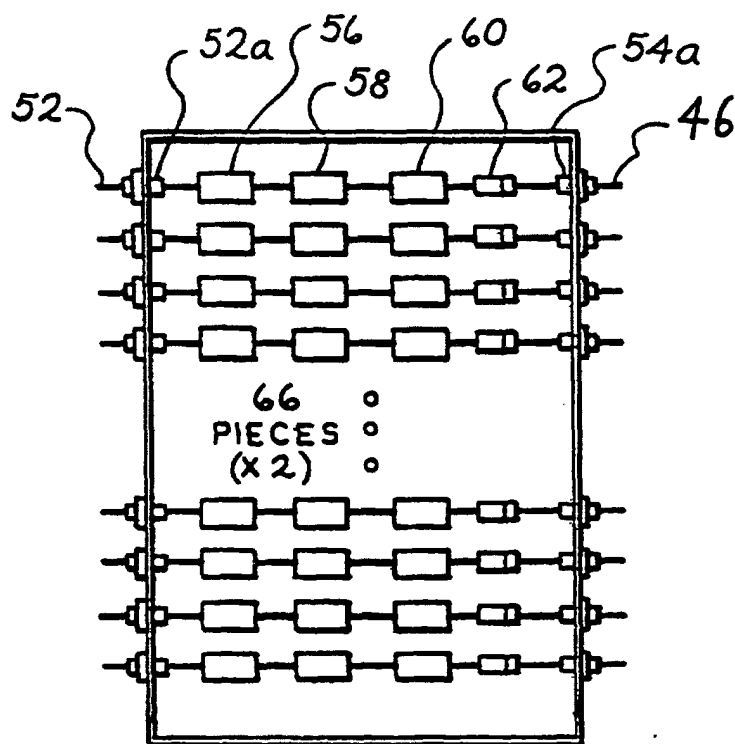


Fig. 3c